Space Weather Technical Forecast

Issued on Monday 28 October 2024 at 00:44 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: S2 Moderate Radiation Storm ongoing. Glancing CME may bring G1-G2 Minor to Moderate storms early day 1 (28 Oct). Further M-class flares expected with chance of X-class flares.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Moderate with peak flare M2.8 at 27/2324 UTC from AR3878. There are twelve sunspot regions currently on the disc. The most complex of these is AR3872, which is the central component of three broad, complex regions across the southeast which includes AR3869 to the west and AR3873 to the east. This region has the largest main spot which includes a delta spot on its northern periphery, with some very slight increase in penumbral extent. The most notable development had been in AR3876, to the northwest of this group, but still in the southeast quadrant. This saw growth within its intermediate spots and an ongoing increase in penumbra extent, but this development has recently stalled. The other spots on the disc are mostly simple, or smaller, with only slow growth or decay observed. However, the new region moving onto the disc from over the northeast limb is bright in SDO aia-imagery, and is starting to show some potential complexity as it moves into a less oblique viewing angle, but remains difficult to analyse.

No Earth-directed CMEs were observed in this period.

Solar Wind / Geomagnetic Activity: The solar environment through the day showed a slight decline due to the arrival of a glancing CME on the 26 Oct originating from the X3.3 flare on 24 Oct. A further glancing CME arrival was also likely observed later on the 27 Oct, likely from the X1.8 flare on 26 Oct. Solar winds, observed by ACE at L1, were slightly elevated throughout this period, on a slow declining trend, peaking at around 480km/s around 27/0440 UTC. Some slight perturbation to the solar wind was then observed around 27/2230 UTC which may have been a further glancing CME, but no notable increase was observed. Density was at or near average for much of the period, but became above average for a time around 27/2230 UTC. Interplanetary Magnetic Field (IMF), Bt, was initially strong at around 20nT but then eased to weak levels by the end of the period, showing no enhancement from the potential glancing CME. The north-south component was initially weak to moderate and mainly positive (northward), but varied weakly from around 27/1030 UTC. Phi angle remained negative (towards the Sun), perhaps indicating some influence of CH84/- fast wind. Geomagnetic activity was Quiet to Unsettled (Kp1-3).

Energetic Particles / Solar Radiation: High energy proton flux observed by GOES18 rose gradually for much of the period, initially above the S1 Minor Storm level, it surpassed the S2

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Moderate storm level just after 27/0830 UTC. This peaked 273pfu at 27/1535 UTC, at which point it became relatively steady until the end of the period. This is likely due to the protons swept up ahead of the glancing CME late on 27 Oct. High energy electron flux (greater than 2MeV) observed by GOES16 was Background to Moderate. The associated 24-hour fluence was well below the Active threshold, with 1.57e6 integrated flux observed at 28/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate to High activity is expected, with further M-class flares expected and a chance of isolated X-class flares.

Solar Wind / Geomagnetic Activity: A glancing CME likely associated with the X1.8 flare on 26 Oct may have weakly glanced L1 around 28/2230 UTC. This recent potential glancing impact from this CME gives a chance of G1-G2 Minor to Moderate storms in the coming hours, but if Earth sees more of the CME then an isolated G3 Strong storm cannot be ruled out. However, it has also not been completely ruled out that the majority of the CME misses Earth, and only a very slight glancing impact continues to be observed. This will likely become more apparent over the next few hours as we observe this CMEs interaction with Earth.

Ongoing influence of the CME may continue into day 2 (29 Oct), along with any weak connection to CH85/- , with further Active to G1 minor storm intervals possible, however winds will likely to be easing to be slightly elevated, perhaps background by the end of the period. Aside from the CME arrival, mainly Quiet to Unsettled geomagnetic conditions are expected. However, any further notable flares and associated CMEs may change this.

Energetic Particles / Solar Radiation: The high energy proton flux at GOES-18 is currently at S2 Moderate Radiation Storm, and is likely to persist at this level ahead of the CME arrival from the X1.8 flare, which may have already glanced weakly with Earth late on the 27 Oct. A fairly rapid decrease is expected to occur through day 1 (28 Oct), however further flares bring the potential for further enhancement. This includes a slight chance of reaching S3 Strong Storm. The high energy electron flux is expected to persist at mainly background, but may see a rising trend later in the period. However the associated fluence is forecast to persist below Active.

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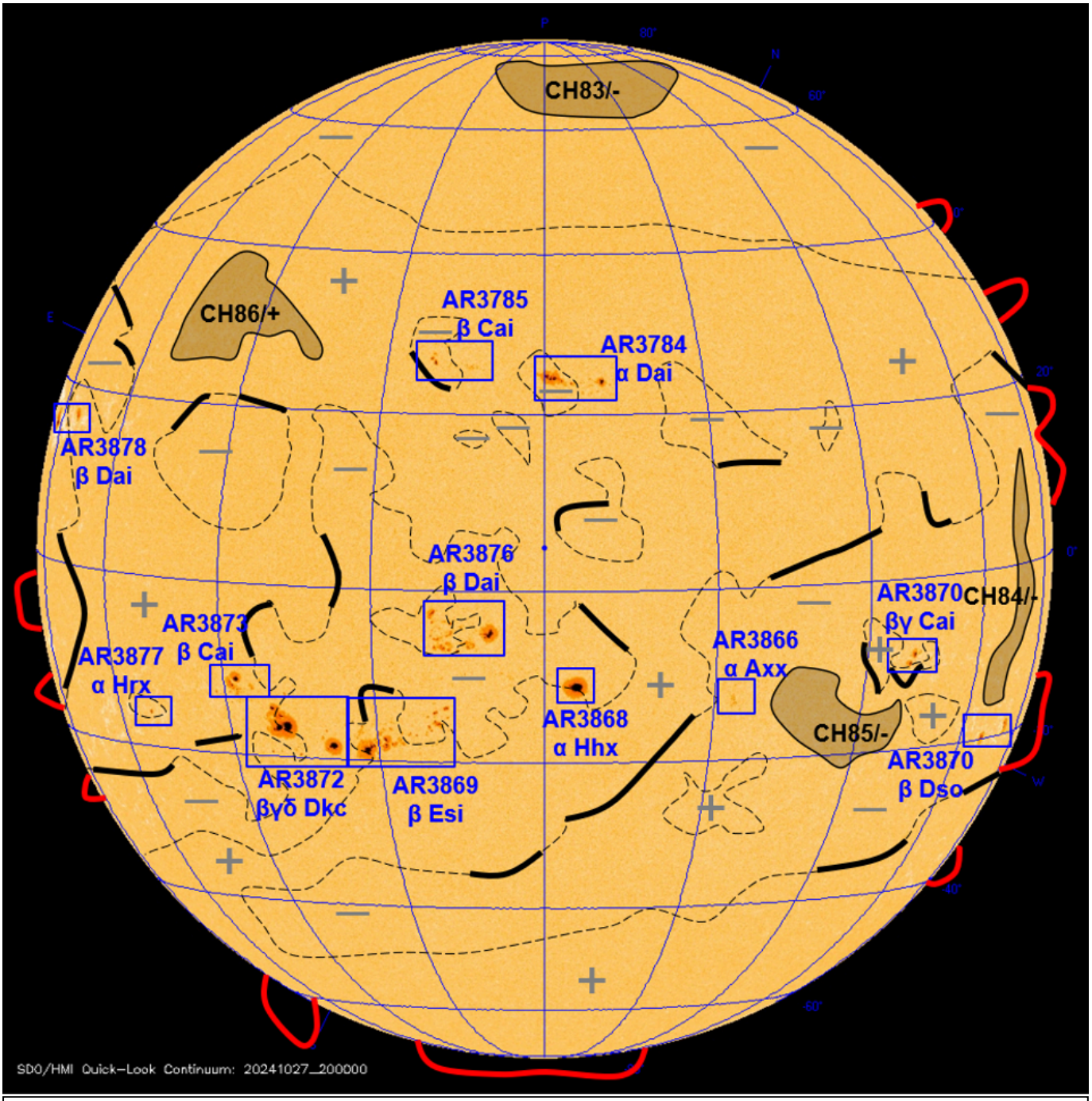
Figure 1: Solar Synoptic Map 27/2000 UTC



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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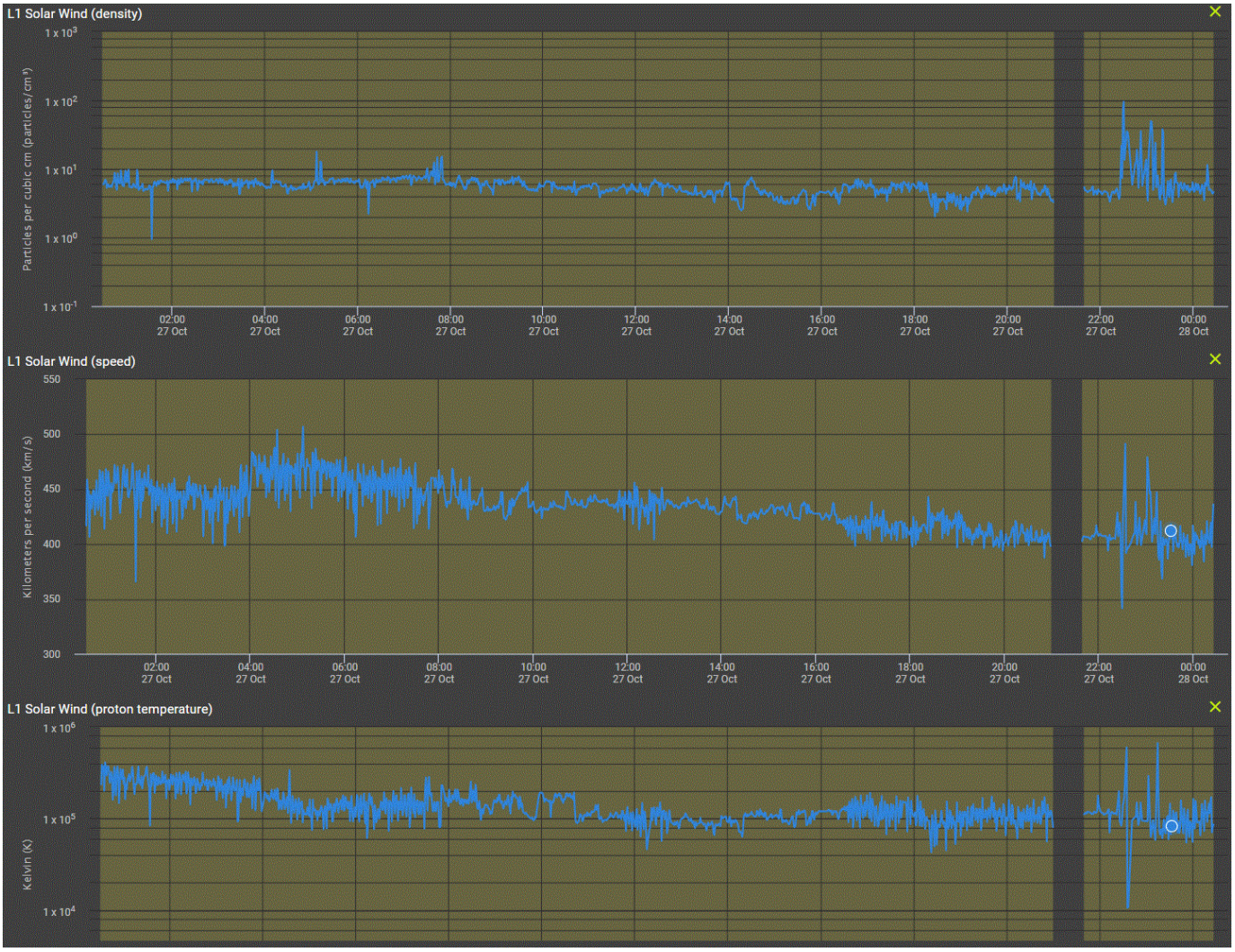
Figure 2: L1 (ACE) Observed solar winds, showing weak CME arrival



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Geomagnetic Storms

The geomagnetic forecast has some significant uncertainty initially due to the low confidence influence of the CME from the X1.8 flare on 26 Oct. This was a notable and relatively fast CME, but has the bulk of its material passing south and behind (east of) Earth. However, coronagraph imagery from SOHO shows a notable shock extending further west than the previous X3.3 CME, which was observed weakly glancing Earth on 26 Oct.

This CME may have weakly glanced with L1 at around 27/2230UTC with a spike observed in energetic protons, which has been showing the 'snow-plough' effect of an incoming CME, gradually building through the last 24 hours. At time of writing this potential glance from the CME has had a negligible effect on the Interplanetary Magnetic Field (IMF) but will have to be monitored over the next few hours.

This recent potential glancing impact from this CME gives a chance of G1-G2 Minor to Moderate storms in the coming hours, but if Earth sees more of the CME then an isolated G3 Strong storm cannot be ruled out. However, it has also not been completely ruled out that the majority of the CME misses Earth, and only a very slight glancing impact continues to be observed. This will likely become more apparent over the next few hours as we observe this CMEs interaction with Earth.

Ongoing influence of the CME may continue into day 2 (29 Oct), along with any weak connection to CH85/- , with further Active to G1 minor storm intervals possible, however winds will likely to be easing to be slightly elevated, perhaps background by the end of the period. Aside from the CME arrival, mainly Quiet to Unsettled geomagnetic conditions are expected. However, any further notable flares and associated CMEs may change this.

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	**G1 to G2**	No	50	20	5	5
Strong	**G3**	No	15	1	1	1
Severe	**G4**	No	2	1	1	1
Extreme	**G5**	No	1	1	1	1

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Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R⊙ (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed (km/s)	Estimated Arrival Time (UTC)	Comments
2024-10-26 09:40	Partial	X1.8 flare	SE	1493	28/0500 UTC	Moderate confidence in Earth-directed shock. Arrival +/- 8hrs

Figure 3: MOSWOC Enlil showing bulk of CME to south and east of Earth, with glancing impact.

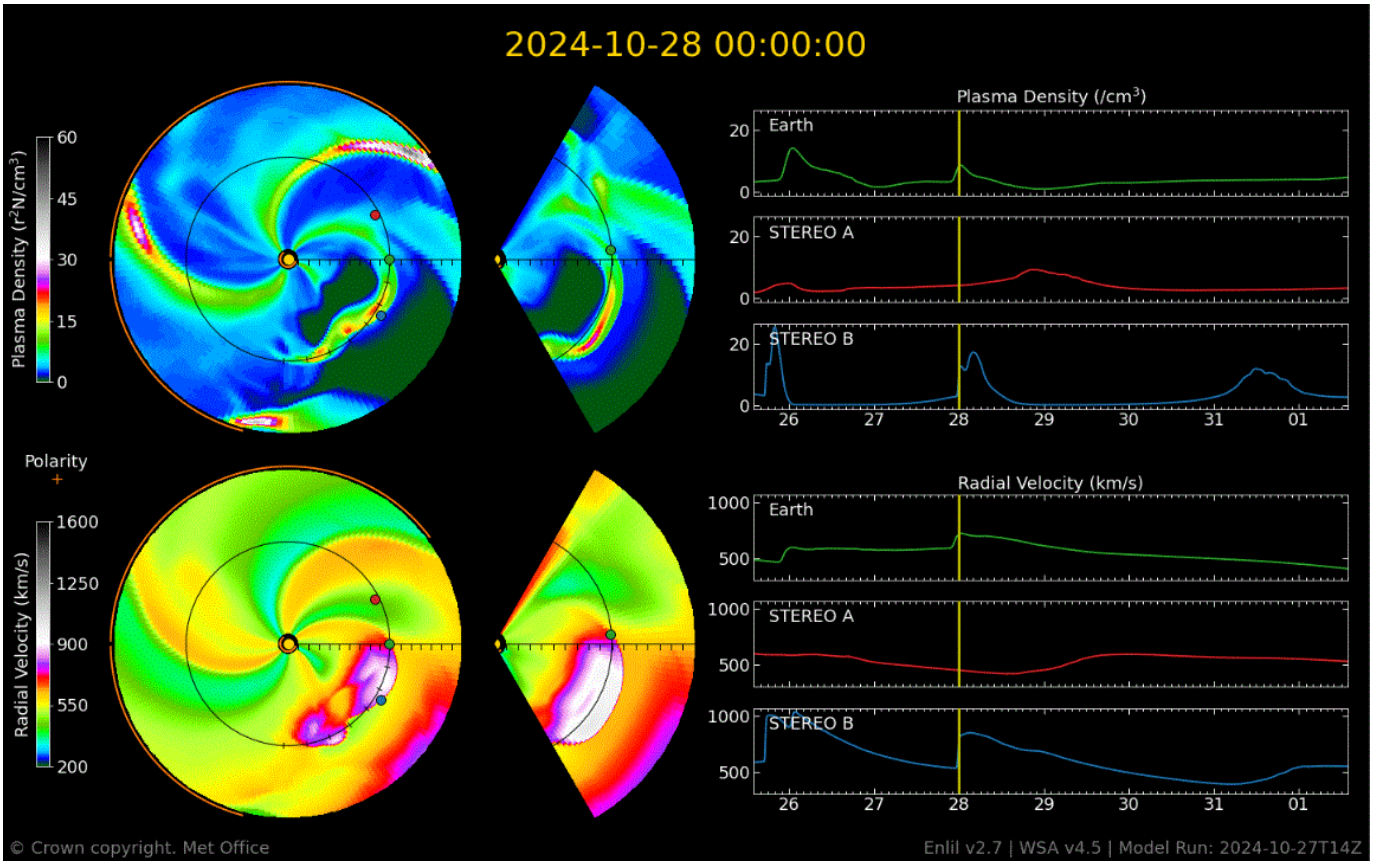

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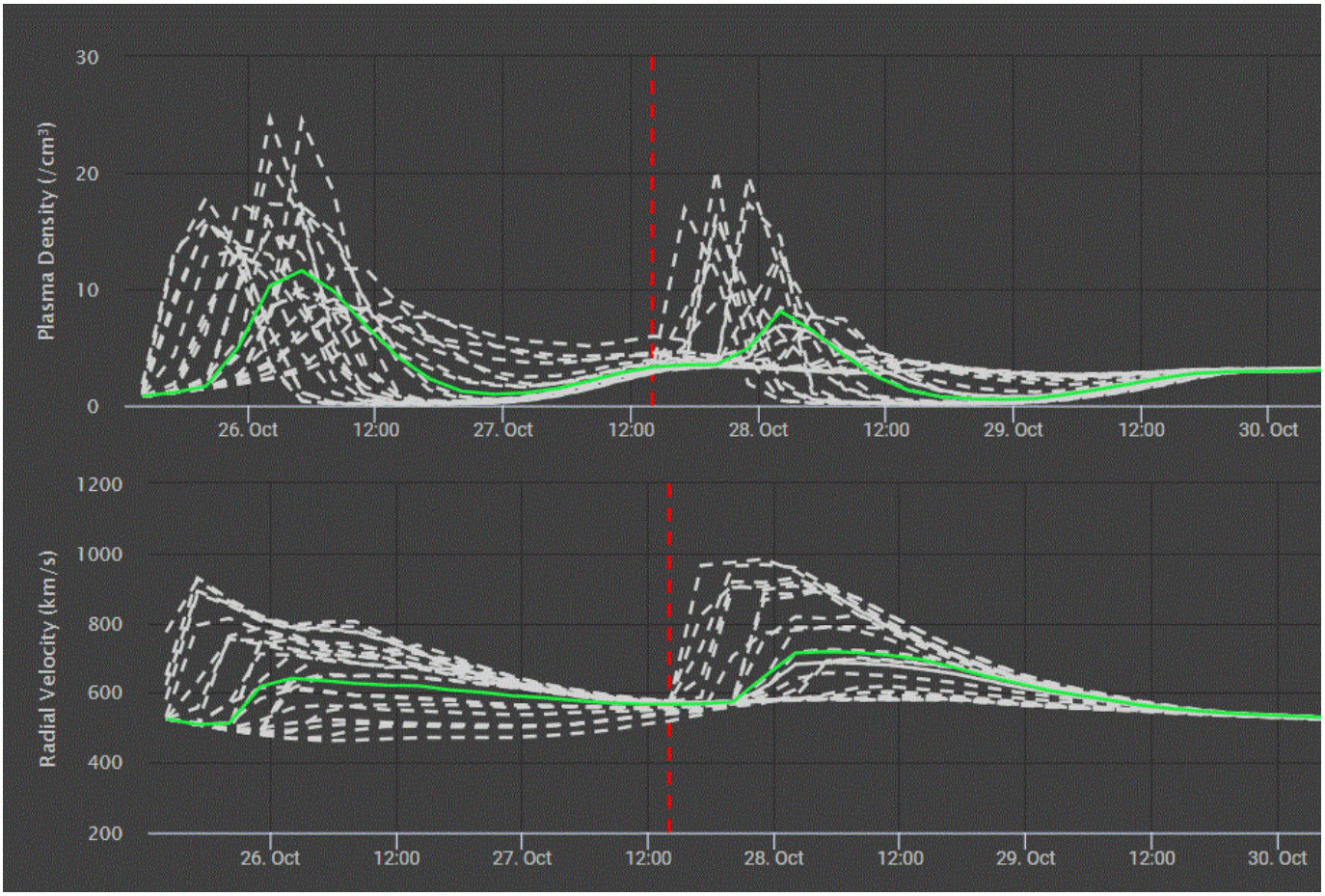
Figure 4: Ensemble, which explores the uncertainty of the CME analysis.



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Radio Blackouts - X-Ray Flares

Moderate to High activity is expected, with further M-class flares and a chance of isolated X-class flares, given the complexity and number of regions on the disc. These most likely from the southeast complex, including AR3869/72/73.

There are twelve sunspot regions currently on the disc. The most complex of these is AR3872, which is the central component of broad complex of regions across the southeast which includes AR3869 to the west and AR3873 to the east. This region has the largest main spot which includes a delta spot on its northern periphery, with some very slight increase in penumbral extent. The most notable development had been in AR3876, to the northwest of this group, but still in the southeast quadrant. This saw growth within its intermediate spots and an ongoing increase in penumbra extent, but this development has recently stalled. The other spots on the disc are mostly simple, or smaller, with only slow growth or decay observed. However, the new region moving onto the disc from over the northeast limb is bright in SDO aia-imagery, and is starting to show some potential complexity as it moves into a less oblique viewing angle, but remains difficult to analyse.

X-Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 (M Class)	No	80	80	80	80
Very Active	R3-R5 (X Class)	No	30	25	20	20

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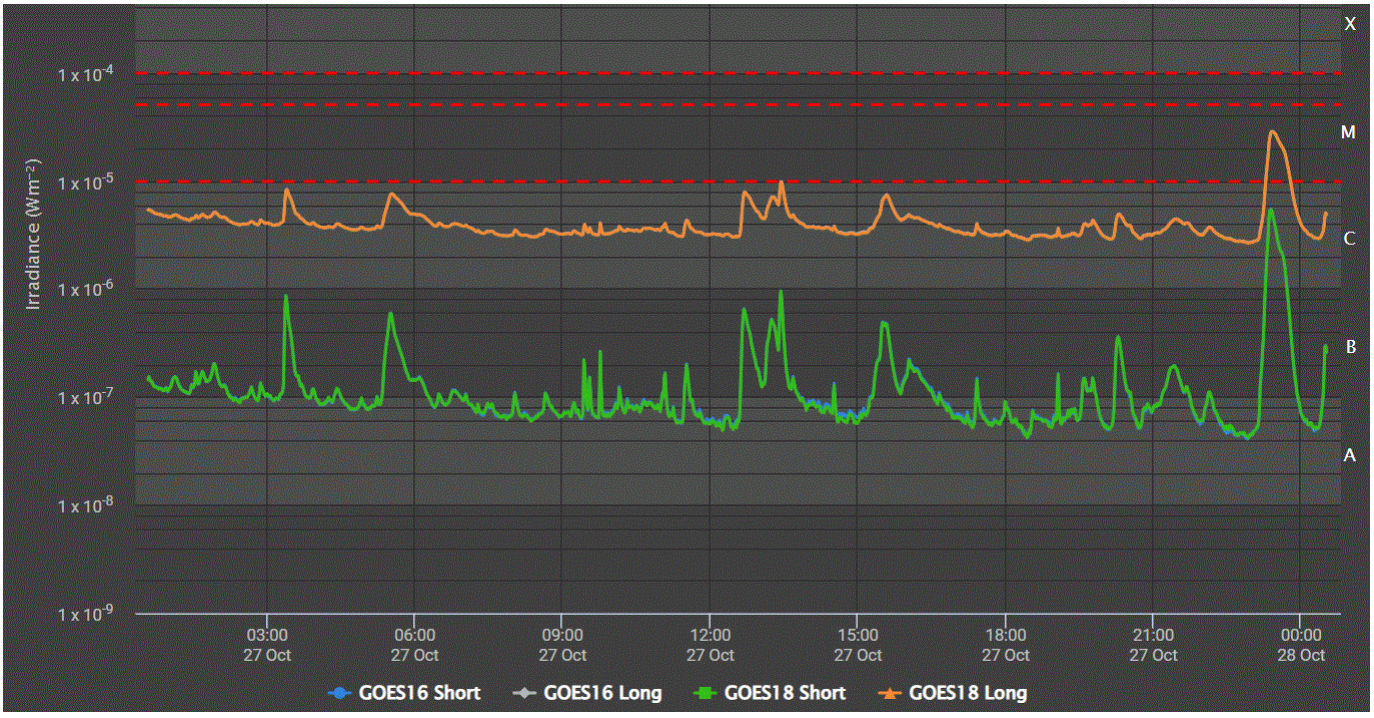
Figure 5: GOES-16/18 X-ray flux



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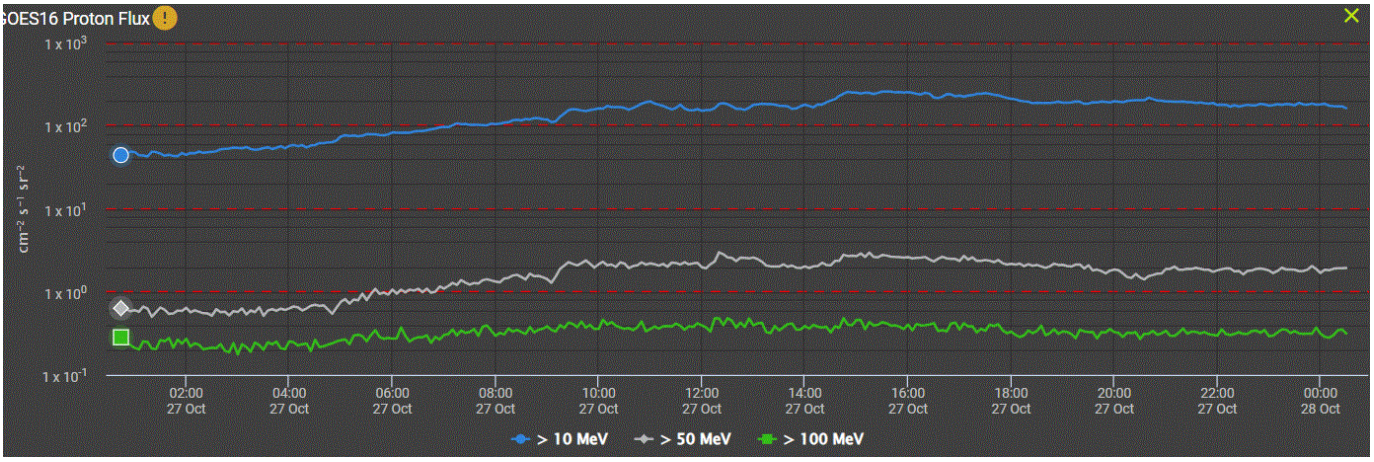
Solar Radiation Storms (High Energy Protons)

High energy proton flux at GOES-18 is currently at S2 Moderate Radiation storms, likely due to the 'snowplough' type affect of the approaching CME, after the X1.8 flare on 26 Oct. This flare, alongside the X3.3 flare on 24 Oct are both likely sources of these observed protons.

Observed protons are expected to persist at the S2 level until the arrival of the CME from the X1.8 flare, which may have already glanced weakly with Earth late on the 27 Oct. A fairly rapid decrease is expected to occur through day 1 (28 October). However, given the potential for further notable flares from the region(s) that produced these proton storms, and with these regions moving into a more geoeffective location, the potential for further enhancement is maintained throughout. This includes a slight chance of reaching the S3 Strong Radiation Storm level.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	Yes	99	80	25	25
Very Active	**≥ S3 ***	No	20	15	10	10
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 6: GOES-18 proton flux over the past 24 hours for >10MeV, >50MeV and >100MeV.



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High Energy Electrons (≥ 2MeV)

High energy electron flux (greater than 2MeV) as observed by GOES16 is currently at Background levels, and is expected to persist mainly at this level, due to the ongoing CME influence and the further forecast CME arrival early on day 1 (28 Oct), which may have already glanced with earth late on the 27 Oct. As this influence recedes, there is a slight chance of the observed electron flux increasing at GOES, likely rising to Moderate with a slight chance of reaching High into day 3 (30 Oct).

The associated 24-hour fluence is currently expected to remain well below Active throughout the period, with the MOSWOC REFM forecast though to be providing good guidance. However this guidance may become less useful, after the arrival of any CME on 28 Oct.

GEO Electron Environment Probability (Exceedance)	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ 1×10^{8}**	No	1	1	5	10
Very Active	**≥ 2 MeV ≥ 1×10^{9}**	No	1	1	1	1

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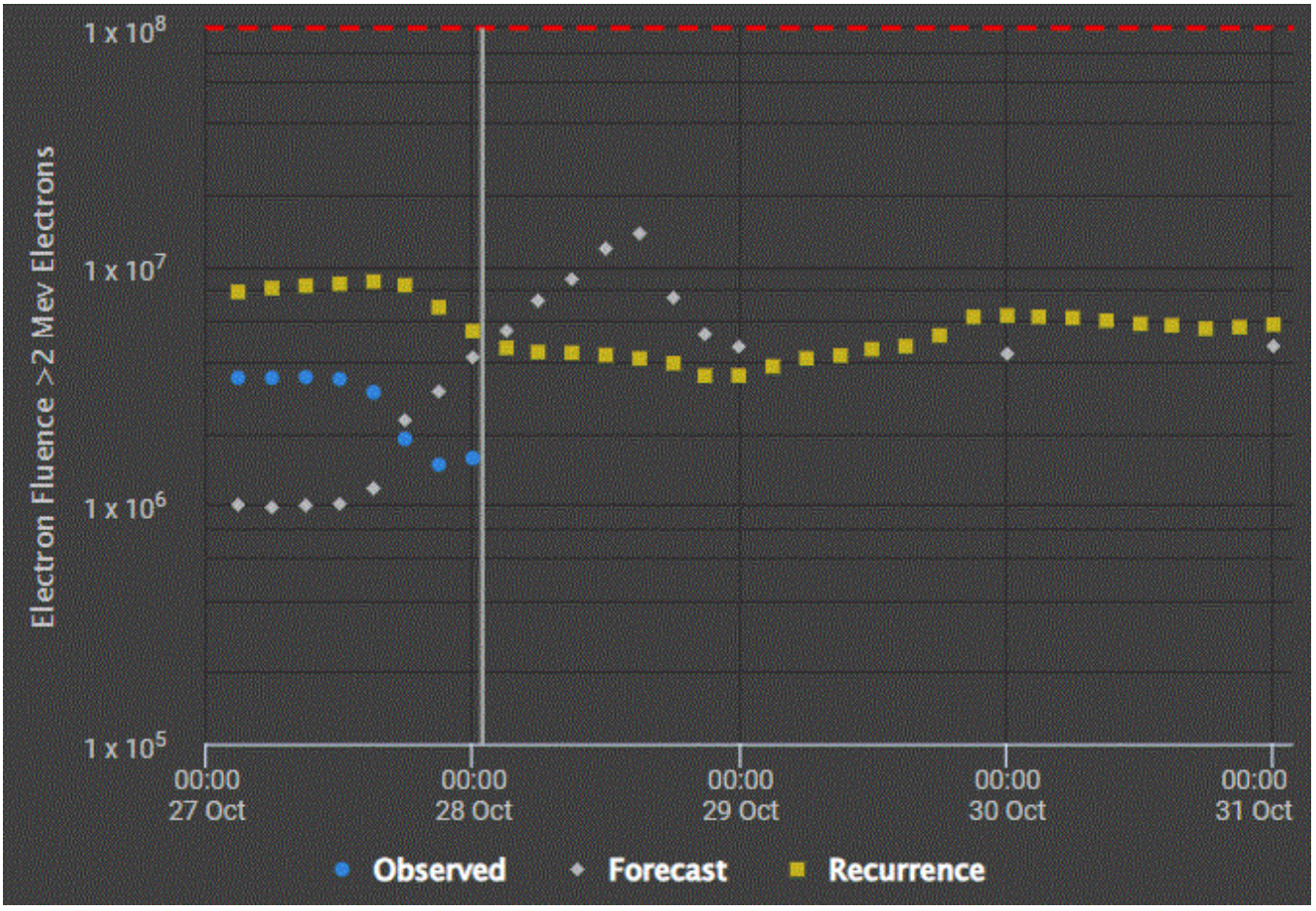
Figure 7: GOES-16 24hr >10 MeV Electron Fluence with REFM



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